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Use of healthier fats in biscuits (olive and sunflower oil): changing sensory features and their relation with consumers' liking

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ABSTRACT

The aim of this study was to evaluate consumer acceptability of biscuits when saturated fat was replaced by olive or sunflower oil and to determine the sensory characteristics responsible for changes in acceptability. Ninety seven consumers evaluated the acceptability of six biscuit samples varying in the fat source (dairy shortening, olive oil and sunflower oil) and fat content (10.6% and 15.6%). Using a Check All That Apply question (CATA), consumers also evaluated sensory properties of biscuits. Results indicated that the replacement of saturated fat (dairy shortening) by vegetable oils had an effect on biscuit acceptability which depended on biscuit fat content. According to biscuits' acceptability data, three different clusters of consumers were identified. By using a multiple factor analysis, the relationship among sensory CATA data and acceptability of each cluster explained the different acceptability patterns of consumers. For most of consumers acceptability was related to attributes "crispy", "easy to chew" and "biscuit flavour" which, for one group were perceived in shortening biscuits and, for another in both olive and shortening biscuits. However, for the third group of consumers, acceptability was only related to flavour attributes like "roasted flavour" or "biscuit flavour" that were perceived in vegetable oil biscuits which were the preferred biscuits while, shortening biscuits were disliked and perceived as having an "off flavour".

1. Introduction

The use of selected vegetable oils as a replacement of solid fats in biscuits is an alternative to make products with a healthier fatty acid profile. However, due to the fact that fat is one of the main ingredients; and it is responsible for the biscuit's characteristic texture, mouthfeel and flavour reducing the fat content or replacing fat with other ingredients has a considerable impact on the mechanical properties which in turn, might affect sensory perception and, thereby have important implications for consumer acceptance of such products (Baltsavias, Jurgens, & Van Vliet, 1999; Rodríguez-García, Laguna, Puig, Salvador, & Hernando, 2013; Zoulias, Oreopoulou, & Tzia, 2002). In the development of such new products, food companies require information about how consumers perceive the sensory characteristics of the product and which sensory attributes drive the acceptability in order to design food products that match consumer expectations (Guinard, Uotani, & Schlich, 2001; Ten Kleij & Musters, 2003). Usually, the study of the relationship between the acceptability and the sensory characteristics of a product is carried out by comparing descriptive analysis data and consumer data, although the best way to understand consumer preferences is using consumer data. In this sense, the use of the check-all-that-apply questions (CATA) can be useful to gather information about consumers' perception of food products by the selection of the terms from a list that consumers consider appropriate when describing a product.

Previous studies have shown that the reduction of fat content or its replacement with a less saturated fat affects the technological or sensory characteristics of different products, mainly of those in which fat is one of the major components of the formulae (Morales-Irigoyen, Severiano-Pérez, Rodriguez-Huezo, & Totosaus, 2012). When the fat content of a food product is reduced, it is interesting to know to which extent consumers perceive the changes induced in the product and, eventually, if those changes affect the acceptability of the product. For instance, a partial replacement (20%) of pork backfat with olive oil in fermented sausages resulted in low-fat sausages with an unacceptable appearance (Muguerza, Ansorena, & Astiasaran, 2003). Particularly, regarding the fat replacement in biscuits, Zoulias et al. studied the shortening replacement with different fat mimetics up to 35% in biscuits and they found that in all cases, the biscuit's acceptability decreases with respect to the biscuits prepared with shortening (Zoulias, Oreopoulou, & Kounalaki, 2002). In another work carried out by Sudha, Srivastava, Vetrimani, and Leelavathi (2007), maltodextrine and polydextrose were used to replace shortening in biscuits, and the sensory evaluation results showed that the colour and appearance of the biscuits improved when fat was replaced with this carbohydrates at 50% and 60% levels. However, the texture, taste and flavour significantly decrease when the fat was replaced by both maltodextrine and

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polydextrose pointing out that it was not easy to replace the lubricity, flavour or taste imparted by fat in biscuits formulation by replacing it.

Therefore, the type or amount of fat may produce significant changes in the physical properties of food products.

A previous study demonstrated that the use of vegetable oil (olive or sunflower oil) and/or fat reduction in biscuits result in changes in the mechanical and acoustical responses of biscuits that consumers perceive as differences in hardness, crunchiness, mealiness and crumbliness (Tarancón, Sanz, Salvador, & Tárrega, 2014). Hence, it is interesting to evaluate which sensory changes might be involved in the consumers' acceptability of biscuits when the acid fatty profile is improved.

Hereby, the aim of this study was to evaluate consumer acceptability of biscuits when a dairy shortening rich in saturated fat was replaced by olive or sunflower oil and to determine the sensory characteristics responsible for changes in acceptability.

2. Materials and methods

2.1. Sample description

Biscuit samples varied in the type of fat, i.e., a dairy shortening, an olive oil/gel system and a sunflower oil/gel system, and in the fat content, i.e., low fat content (10.6%) and high fat content (15.6%). The shortening used was a dairy shortening (Vandemoortele, Diexpa ref. 402684, Valencia, Spain) commonly used in the manufacture of biscuits. The procedure of the preparation of the oil/gel systems is described in detail in a previous work (Tarancón, Salvador, & Sanz, 2013). Briefly, the oil/gel systems were prepared with sunflower oil (Coosol, Jaén, Spain) or olive oil (Fontoliva, Jaén, Spain) and with the thickener hydroxypropyl methylcellulose ((HPMC), Methocel Food Grade K4M FG, The Dow Chemical Co., Midland, Michigan, USA). In the oil/gel systems, the proportions of oil, water and thickener employed were 47%, 51% and 2%, respectively. The HPMC was first dispersed in oil using a Heidolph stirrer and the mixture was then hydrated by gradually adding the water while continuing to stir.

The amounts of the rest of ingredients in the formulation were kept constant (dough weight basis): soft wheat flour 57.5% (Harinas Segura, S.L., Valencia, Spain; composition data provided by the supplier: 11% protein, 0.6% ash; alveograph parameters P/L = 0.27, in which P = maximum pressure required and L = extensibility, and W = 134, where W = baking strength of the dough), sugar 17% (Azucarera Ebro, Madrid, Spain), skimmed milk powder 1% (Central Lechera Asturiana, Spain), salt 0.6%, sodium bicarbonate 0.2% (A. Martínez, Cheste, Spain), and ammonium hydrogen carbonate 0.11% (Panreac Quimica, Barcelona, Spain). Dairy shortening or vegetable oil systems were added to achieve 15.6% of fat content in high fat baked biscuits or 10.6% fat content in low fat baked biscuits. The water added in each formulation ranged from 12.8% for low fat content biscuits to 5.1% for high fat biscuits. In the formulations with the oil/gel system, glycerol (1.8%) (Panreac Quimica, Barcelona, Spain) was also added to control the water activity.

2.2. Biscuit preparation

The shortening or the oil/gel system, sugar, milk powder, leaving agents, salt, water and glycerol (added only in formulations with the oil/gel system) were mixed in a mixer (Kenwood Ltd., UK) for 1 min at low speed (60 rpm), the bowl was scraped down and the mixture was mixed again for 3 min at a higher speed (255 rpm). The flour was added and mixed in for 20 s at 60 rpm, then mixed for a further 40 s at 60 rpm, after having scraped down the bowl once more. The dough was sheeted with a sheeting machine (Parber, Bilbao, Spain) and moulded into pieces of 52 mm in diameter × 3.4 mm in thickness. Twenty biscuits were placed on a perforated tray and baked in a conventional oven (De Dietrich, Basingstoke, UK) for 20 min at 170 °C (10 min each side of the tray to ensure homogenous baking). The oven and the oven trays were always the same, the trays were placed at the same level in the oven and the number of biscuits baked was always the same. After cooling, the biscuits were packed in heat-sealed metalized polypropylene bags, stored and evaluated after 24 h.

2.3. Consumer test

Ninety seven consumers (80 women and 17 men) from 23 to 65 years old participated in the study. For each sample and in blind condition, consumers had to score the acceptability using a nine-point hedonic scale ranging from 1 ("dislike extremely") to 9 ("like extremely"). After that, consumers were asked to answer a CATA question comprising 22 sensory descriptors. These descriptors were selected based on results from a previous study in which 28 consumers generated their own set of terms by using the Repertory Grid method (Tarancón, Fiszman, Salvador, & Tárrega, 2013). They were: "crispy", "hard", "dry", "easy to swallow", "fat mouthfeel", "hard to chew", "easy to chew", "crumbly", "brittle", "mealy", "soft", "butter flavour", "biscuit flavour", "roasted flavour", "tasteless", "off-flavour", "not very sweet", "rancid flavour", "unpleasant aftertaste", "very sweet", "vanilla flavour" and "artificial flavour". Each consumer was asked to check the terms that he or she considered appropriate to describe the biscuit sample. The evaluations were carried out in a standardized test room (ISO, 2007); the six biscuits samples were served in white plastic dishes identified with random three-digit codes and they were presented monadically following a Williams design (MacFie, Bratchell, Greenhoff, & Vallis, 1989). Consumers were asked to rinse their mouths with water between each sample.

2.4. Data analysis

The individual acceptance responses of consumers to each product were analysed by a preference map using a PCA on the correlation matrix of consumers' individual acceptance data (MacFie & Thompson, 1998), and the results were expressed as a scatter plot of samples and individual consumers in relation to the first two principal dimensions.

A hierarchical cluster analysis was performed on acceptability data in order to identify groups of consumers with similar preference patterns, and Euclidean distances and Ward's aggregation method were considered. Then, analysis of variance of two factors (fat type and fat content) was used to study the variability of the preference among samples in each cluster. Significant differences between individual samples were determined by the Least Significant Difference (LSD) of Fisher test ($\alpha = 0.05$). The non-parametric Cochran's test analysis of variance was performed for each descriptor to evaluate if the CATA question was able to detect differences in consumer perception of the biscuits. For a descriptor, when the differences among samples were significant according to Cochran's test but the frequencies of mention for any sample were below 10, it was not further considered. Overall variability in the frequencies of mention of significant attributes was analysed by using a Correspondence Analysis (CA). Finally, in order to assess the relationship between CATA question responses and biscuit acceptability scores, a Multiple Factor Analysis (MFA) was performed on the frequency of mention of the CATA question for each cluster. All calculations were carried out with XLSTAT 2009.4.03 (Addinsoft, Barcelona, Spain).

3. Results and discussion

3.1. Biscuit acceptability: influence of individual preferences

The acceptability of biscuit samples was evaluated by consumers. A preference map was obtained, explaining 59.8% of the overall variability of the acceptability data (Fig. 1). The first dimension accounted for 40.1% of the variability and separated the samples according to biscuit fat